DEMAND FOR AGRICULTURAL CREDIT BY RURAL SMALLHOLDER FARMERS: A CASE OF CLIMATE SMART AGRICULTURE VILLAGES IN NYANDO BASIN, KENYA

By

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DECLARATION

This research paper is my original work and has not been presented for any degree award in any institution.

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SUPERVISORS' DECLARATION

This research paper has been submitted for examination with our approval as university supervisors.

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ABSTRACT

The effect of climate change and variability on agricultural production systems cannot be underestimated especially in rural areas. Farmers more than often experience increased agricultural losses and reduced productivity due to weather vagaries, little or no investment in their farms etc. Rural smallholder farmers are most affected and are faced with a number of challenges such as lack of insurance services, limited access to credit facilities especially from formal sources, among many others problems as they try to adapt and mitigate the impact of changing climatic conditions and effects of global warming. With the absence of insurance and limited access to financial resources (agricultural credit) the ability of the farmers to adopt smart farming technologies that can cushion them from such losses is threatened. In order to inform policy a lot of research work has been done on agricultural credit but resulted to inconsistent findings and conclusions in different regions. With such in mind, more research is needed on credit market participation, the intensity of participation and the choice of credit market more so in specific regions of the developing countries. The findings of these studies will augment the already existing knowledge and policies that actually reflect the needs of those particular communities for rural sustainable development in general and agriculture in particular. This research paper assessed loan facilities demanded by smallholder farmers', factors affecting borrowing decisions and the subsequent factors that influence the intensity of borrowing by these farmers in climate-smart villages of Nyando, Kisumu in an attempt to finance agricultural production and adopt smart farming practices. By use of stratified sampling a 120 households were sampled from participating and non-participating households. Data on individual, institutional and socioeconomic characteristics was collected from these farm households by university of Nairobi masters students in conjunction with CCAFS using structured questionnaire. Data analysis employed descriptive and quantitative methods using double hurdle model. The findings show that loan repayment period, number of groups household members are into and collateral influence positively the household decision to borrow with the intensity of participation being positively and significantly influenced by loan repayment period and household wealth endowment. Therefore groups should be used to finance farmers and unlock their economic potential.

DEDICATION

I dedicate this work to my lovely wife (Claudia Jane and my unborn child), my caring and always supportive parents (Regina and Musembi), my brothers (Sylvester and victor) and sisters (Jennifer, Jane, and Cecilia) for their love, encouragement, and support throughout the academic journey.

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ACRONYMS AND ABBREVIATIONS

ASAL	Arid and Semi-Arid Lands
CCAFS	Climate Change Agriculture and Food Security
CGIAR	Consultative group for international agricultural research
CSA	Climate-smart agriculture
CSAP	Climate-smart agriculture practices
AGRA	Alliance for green revolution in Africa
OECD	Organization for economic corporation and development
GDP	Gross domestic product
IMF	International monetary fund
PDF	Probability distribution function
ILRI	International Livestock Research Institute
CIAT	International Center for Tropical Agriculture
UNFCCC	United Nations Framework Convention on Climate Change

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CHAPTER ONE: INTRODUCTION

1.1 Background of the study

The importance of agriculture in solving the problem of food security can be seen from the priority it's accorded in the African development agenda. It is also through agriculture that the world targets to achieve sustainable development agenda two of ending hunger by 2030. Agriculture accounts for 15% of total global GDP and 32% in Africa (OECD and FAO, 2016). It employs over half of the labour force, and it's the means of livelihood for a majority of rural smallholder farmers (IMF, 2012). Smallholder farms account for approximately 80% of all farms in sub-Saharan Africa and employ about 175 million people directly (AGRA, 2014). In these countries, women provide over half of the total labor force (FAO, 2015). Dixon et al., (2003), smallholder farmers in Africa are classified using agro-ecological zones, farm portfolio, land size and returns from farming activities. In densely populated areas these farmers own and farm on less than a hectare of land although the size of land might go up to ten hectares in less populated areas (Ibid)

In Kenya, agriculture is still the leading contributor to real GDP although its contribution has been declining since 1964. The sector contributed 36.6% of the real GDP in the period between 1964 and 1974 and continued to decline from 26.5% to 24.5% in the periods from 1990 to 1995, and 1996 to 2000, respectively (Kabubo-Mariara & Karanja, 2007). Hitherto, the sector has remained a key contributor to Kenya's economic development accounting for 32% of the country's GDP and 65% of total exports earnings, while employing over 80% of the county's rural working population and about 18% of total formal employment. The official figures are

scanty but it is approximated that women represent about 48% of the total agricultural work force. The continued reliance on agriculture and the importation of maize, rice and wheat among others which are Kenya's major staple foods amplify the need for sustainable, resilient increase in productivity for food security and economic growth through promotion of CSA initiatives (World Bank, CIAT, 2015).

Smallholder production in the country is mainly subsistence. It faces a lot of challenges such as limited or no access to credit, inability to access or afford production inputs and irrigation equipment, lack or limited access to markets, limited market information and agricultural extension services, all of which hamper agricultural investments adding to the risk of food insecurity (Ibid). The production potential of smallholder farmers can be ameliorated by adoption of modern farming practices, but financial constraints remain a major barrier (Rosegrant et al., 2002). Farm credit plays an integral part in enhancing agricultural productivity. It facilitates farmers' access to agricultural inputs such as planting materials, fertilizers, and financing other farm activities like weeding, harvesting and marketing farm products where farmers' incomes fall short. Credit facilities help in improving the welfare of the rural poor farmers via financing consumptions as well as reducing the opportunity costs of vital assets (Auma & Mensah, 2014).

In 2011, an estimated 3.5 million Kenyans were declared food insecure, which is an increase compared to 1.5million in 2009. This was as a result of below average rainfall making it the driest year since 1950 (World Bank, CIAT, 2015). One such area where people are food insecure is the Nyando basin which was the area of our study. Poor land preparation, lack of proper crop husbandry during the growing period and harvest and post-harvest losses, unreliable and

inadequate rainfall, lack of credit facilities or access and climatic shocks like droughts and flooding are some of the challenges farmers face during the production period in Nyando basin (CCAFS, 2012).

The Nyando basin has two rain seasons; March to May, and October to December. Smallholder farmers in this area cultivate mainly seasonal food crops e.g. maize, beans, sorghum, millet, sweet potatoes and keep goats, sheep, chicken and in some households cattle (CCAFS, 2012). The farmers prepare their land and sow/plant between February and March (Ibid). Most farmers in the area hire tractors for ploughing and harrowing as they prepare to plant. Hiring tractors, farm labour, agricultural inputs such as certified drought and pests tolerant seeds, fertilizers, weeding, and pesticides requires financial resources. The income of smallholder farmers in Nyando is low. To finance these activities farmers may need to seek additional financial resources which mainly come from informal credit sources. The harvesting period runs from June to July. With the threat of harvest and post-harvest losses due to pests, disease and deteriorating quality, farmers ought to harvest and store their crops within the shortest time to minimize such losses. Harvesting is labor intensive and requires extra labor especially where family labour is not enough. It is through credit that these households hire casual labour to supplement family labour. The cropping seasons in the basin have been affected and change almost always due to climate change and variability. Occasionally the rains fail, or it's inadequate resulting to crop failure while in other times the area experience floods that affect the farming calendar, destroy crops, kill livestock and displace farmers from their farms.

Provision of good quality inputs, better and stable markets, better and sustainable land management practices, innovative agricultural financing and climate-smart technologies and practices are critical for sustained agricultural production (Njeru et al., 2015). Although the

agricultural sector contributes immensely to Africa's GDP and employs most of the rural workforce, a small fraction of commercial lending is directed to the sector (Jack et al., 2016). Most of it goes directly to the large-scale commercial farmers, crowding out smallholder farmers. Commercial banks lack interest to lend to the sector due to the risky nature of its activities, such as drought-related losses, unpredictable weather patterns, pest and disease attack losses, huge transaction costs and lack of collateral among others which are amplified by fluctuating commodity prices. Also, microfinance institutions prefer lending to the commercial and trade sector where they fetch high returns, resulting in an insignificant allocation of credit to smallholder farmers (Poulton & Kanyiga, 2014).

Two-thirds of rural farmers in the country do not have access to adequate financial services necessary to better their incomes and welfare (Poulton & Kanyiga, 2014). As a result, these farmers turn to informal credit options such as Merry go rounds, farmers/community local groups, borrowing from each other, family savings among others to finance farming activities like planting, buying seeds, weeding, harvesting, and storage and marketing costs and for consumption during in between harvests (Jack et al., 2016). These informal lending sources in most cases lack capacity to provide enough credit for the farmers' needs. This exposes them to difficulties during the production period. These challenges are compounded by the effects of climate change and climate variability. To address the challenges of climate change and variability in the region, CCAFS has introduced climate smart agriculture (CSA) program in the basin.

Agriculture, including agro-industries, receives only a small share of total lending of commercial banks portfolios amounting to about 10% in Africa (Hassan, 2010). Loans are barely given to smallholder farmers and especially to women. According to Sarris (2017), 5 to 10 % more male

smallholder farmers can access credit compared to female smallholder farmers. With better access to credit, modern farming technologies and improved farming practices, the productivity and income levels of the many smallholder farmers can be enhanced (Babcock, 2015). Although credit to smallholder farmers is growing, there is still a considerable deficit that needs to be addressed.

Despite Kenya having a relatively well developed financial sector, access to bank credit by smallholder farmers remains an uphill task. The small number of banks in the rural areas and the high cost of formal credit also make it hard for farmers to access bank credit. Women farmers do not have secure land-owning rights, and this puts them in a disadvantaged position to access formal credit. Most poor farmers do not have bank accounts and even do not know how to open one and those who have do not use them. This makes other financial services like insurance or formal savings unavailable. As a result, farmers' capacity to invest in productivity-enhancing assets is compromised and exposure to spot market vagaries and weather shocks is increased, contributing to greater vulnerability (Sarris, 2017).

One of the ways of coping with vulnerability and changing climate is the adoption of Climate Smart Agriculture (CSA), an approach that helps people to sustainably manage agricultural systems to respond to climate change (Schaller et al., 2017). The concept was developed by FAO aimed at achieving sustainable agricultural development for food security under climate change (FAO, 2013). It is based on the triple objectives of sustainably increasing productivity and incomes, reducing greenhouse gas emissions where applicable and possible, and adapting to climate change. The definition of CSA does not call for strict "triple wins" in every project as some projects can only target one of the three objectives at a time. It is designed to promote synergies among agricultural projects that are environmentally-friendly. Climate Smart

Agriculture (CSA) has gained recognition both globally and locally as a prime solution to the challenges affecting agricultural production caused by climatic changes and global warming (Grosjean et al., 2016). The increased recognition is aimed at bettering agricultural productivity as well as building resilience to climate change risks among smallholder farming and pastoral communities in affected regions.

CSA comprises of different elements including management of farms through sustainable land management systems, livestock, crops, and aquaculture among others. There are some suggested approaches to implement CSA projects that include expanding evidence base through research, supporting enabling policy frameworks, strengthening national and local institutions, enhancing financing options, and implementing practices at field level. Funding options, coupled with right CSA practices, have been associated with increased production (Bryan et al., 2013).

The Consultative Group for International Agriculture Research (CGIAR) program on climate change Agriculture and Food Security (CCAFS) in partnership with VI Agro forestry started a climate-smart village farm program (CSVs) (cross breeding of Galla goat and red Maasai sheep, chicken rearing, greenhouse farming, fodder and tree planting, and water harvesting technologies (micro catchment) among others), targeting smallholder farmers in Nyando. The site suited the program as the area is characterized by high population density, high temperatures, high evaporation rate, a degraded natural environment, degraded soil fertility, unreliable rainfall, occasional flooding, and low agricultural productivity. CSVs are community steered, participatory, and inclusive. Farm households in the climate-smart villages are in self-help groups where over 70% of the active members are women (CCAFS, 2018).

The Galla goat project is a breeding program meant to improve the adaptability of local goats to climate change. These goats grow bigger, faster, have better milk and meat production, fetch higher prices in the market and are suited for harsh condition. Agro forestry is planting of trees and crops and has the potential to curb land degradation by preventing erosion especially by runoff thus it helps improve soils for better agricultural productivity .Several agro forestry practices have been applied in Kenya with positive results. They include; fertilizer trees such as *Calliandra* spp, *Leucena Leucocephala* and *Terminalia browni.* Farmers in Nyando basin quickly started realizing the value of agroforestry, where they do alley/strip cropping, that is, plantings strips of maize, sorghum and other crops in alternating strips of multi-purpose trees that stabilize and enrich the soil (World Bank, CIAT, 2015). As a result, demand for the fodder trees led to the emergence of more nurseries to supply tree seedlings.

Water harvesting is another smart technology where rain water is accumulated and stored for use instead of being let to run off. According to Recha (2017), farmers in Nyando rely on rivers and streams for water but with worsening effect of climate Change, and destruction of water towers river water levels have gone down and others started drying up. However through CSA technologies, farmers are encouraged to practice water harvesting through investing in water harvesting pans (micro catchment). The pans vary in size and capacity ranging from 48000 to 100000 liters per individual household which can be used up to three months.

The other smart technologies are green house and fish farming. Three smart farms (Onyuongo, Lower Kamula and Obinju) were set up and managed by youth and women groups. These smart farms serve as learning sites where farmers learn and acquire aquaculture and green house farming skills which include site selection, soil quality, water quality, pond construction, stock

rating, predator management, harvesting techniques, preservation, marketing and book keeping techniques, Recha (2017).

Financing interventions play a key role in promoting and facilitating adoptions of CSA practices. The adoption of CSA practices supports the development, improvement, and sustainability of agricultural production. Evidence from Nyando climate-smart program has shown that access to credit is an enabler to adopting smart farming practices as the program invented the community innovation fund. Households in Nyando who used to practice subsistence farming especially women-headed households were able to adopt smart farming practices and as a result could afford variety of more nutritious food for their families and pay school fees for their children. Women with the help of the fund could access loans at reasonable rates and and invest in better yielding crops, early varieties and livestock (CCAFS 2017).Although the initiative is no longer advancing loans to these farmers, they are using table banking to save and access loans to continue financing their activities. Through these initiatives women are empowered and are able to help contribute to the household income. CCAFS has been working with other stakeholders like World Neighbors, VI Agroforestry, ILRI and Kenya's Ministry of Livestock Development and the local farmers to improve the productivity of the small ruminants (sheep and goats). Overall, over 400 farm households in Nyando are reaping benefits of the interventions targeting small ruminants of which a good number are women-headed.

1.2 Statement of the Research Problem

Most smallholder farmers, unable to access formal loans from commercial banks, turn to informal financial sources such as shylocks, merry-go-rounds, table banking, traders and pawnbrokers that are not regulated by the Central Bank of Kenya. These informal loan sources are not formally registered and the services extended to those farmers depend mostly on

membership and relationships that have been established over time. The loans from these sources are not sufficient to help farmers buy enough farm inputs, adopt sustainable farming practices, etc. This impedes adoption of substantial investment in agricultural technologies such as climate-smart agriculture, resulting in low productivity and threatening food security in the country.

Further, the effects of climate change continue to affect agricultural productivity across the arid and semi-arid areas (ASALs); and Kenya, being 80% ASAL, has experienced frequent and persistent droughts that are as a result of climate change and climate variability. Climate-smart agriculture is seen to offer a solution to such problems. However adopting CSA requires financial resource investment and most of the poor rural smallholder farmers have low income and limited access to credit. Those problems have been heavily linked to the supply side of credit which has been the focus of most studies, while ignoring the demand side. In addition, the few studies done on the demand side of credit have given inconsistent findings and conclusions (Kofarmata et al., 2016). The contextual and geographical differences across the research areas might have contributed to such discrepancies. Household socio-economic characteristics in a particular area, soil quality, climatic conditions, financial market differences and cultural practices might also have contributed to such disparities. This study adds to the limited literature on the demand side of credit access by assessing the factors influencing agricultural loan market participation, the amount of credit accessed, and the preferred choice of credit market (credit source) in Nyando region, which is representative of many other areas in developing countries. The findings will augment other studies in this area and also inform policy for sustainable rural credit market development.

1.3 Research Questions

This study is guided by the following research questions;

1. What loan facilities do smallholder CSA farmers in Nyando demand at various times in a farming calendar year?
2. What factors influence both farmers' credit market participation and the amount of loan funds demanded by smallholder CSA farmers in Nyando?

1.4 Study Objectives

The main objective of the study is to establish the factors that influence demand for loan funds by smallholder farmers under CSA (Climate-smart agriculture) projects in Nyando. The specific objectives of the study include, to:

1. To determine the loan facilities that smallholder CSA farmers in Nyando demand at various times in a farming calendar year.
2. To identify factors that influence both farmers' credit market participation and the amount of loan funds demanded by smallholder CSA farmers in Nyando.
3. To draw policy recommendations from the study findings.

1.5 The Hypothesis of the Study

The study will test the following hypothesis;

1. Farmers in Nyando basin do not demand for any loan facilities at any time of the year.
2. Hypothesized factors do not have any effect on both farmers' credit market participation and amount demanded.

1.6 The Significance of the Study

This study will shed light on the credit needs among smallholder farmers embracing CSA practices and how the needs are spread along the farming calendar. With such information on smallholder farmers' credit needs, stakeholders in CSA projects in the country can plan, and improve CSA financing. The CSA project needs expansion, especially after realizing the benefits associated with it. Scaling up CSA to other areas should be accompanied by lessons learned like better and sustainable financing.

The study is expected to benefit a broad scope of stakeholders including farmers, scholars, government, and financing/credit-giving organizations. Farmers will benefit from the study if the findings are used to make policies and design financing models that reflect their credit needs, especially for CSA adoption and scaling up. The research will also help scholars by adding to the existing literature on agricultural financing especially on CSA practices. The government can use the information from the study findings to design financing programs consistent with the credit needs of the smallholder CSA adopters. Financial institutions will understand the credit needs of the farmers and their demand, and this will enable them to come up with tailor-made credit facilities addressing their financial needs. Finally, the findings of this study can assist policymakers to come up with better ways to design, implement smallholder farmer financing models.

CHAPTER TWO: LITERATURE REVIEW

This chapter reviews the literature on different aspects of credit/loan facilities needed by smallholder farmers at different times, factors affecting demand for credit, as well as providing literature on how demand for credit/loanable funds is affected by CSA adoption/investment. The motivation of the literature review is informed by the continued demand for loan/credit among the smallholder farmers in Kenya, the challenges associated with persistent low agricultural productivity among these farmers, and the impact of CSA adoption/investment on demand for credit facilities among the smallholder farmers.

2.1 Climate Smart Agriculture and Climate Change

After signing the UNFCCC in 1992, governments and businesses have increased their attention and commitment towards climate change (Kolk et al., 2008). Developing countries are the most vulnerable and affected by climate change effects since they greatly depend on agriculture. According to FAO & EU (2014), the economic development of the emerging nations is being threatened by the effects of climate change and variability on agriculture. Agriculture has been facing enormous challenges of adapting to changing weather conditions, having to contribute to the reduction of greenhouse gases and providing food for the ever-increasing world population. Climate-smart agriculture has been suggested as the solution to these problems since it aims at increasing productivity, enhancing adaptation to climate change and reducing the emission of greenhouse gases.

It is from this premise that a lot of research continue to be carried out on agriculture and climate change on the developing nations (Branca et al., 2011). CSA can be seen as a concept that is bridging the gap between knowledge and policy. This is because it seeks to integrate and form a

basis for the appropriate technical, policy and investment aspects required for agriculture to respond to climate change and meet increased future food demand. The focus has shifted to adoption and diffusion and technological innovations from start-ups to big players playing a significant role in deciding the rate of adoption and diffusion of CSA. Climate-smart agriculture is relatively a new concept and still in its infancy in South East Asia and sub-Saharan Africa. It is a concept that was launched in 2011 and it's still in its initial stages of development. There are pilot programs in west and east Africa. In East Africa it is being piloted in Kenya, Ethiopia, Uganda and Tanzania (CCAFS, 2015). In Kenya, the climate smart village program was started in Nyando basin in Kisumu and Kericho Counties. According to CCAFS (2015), approximately 412 farm households have joined CBOs in the climate-smart village's majority of whom are women.

The diffusion and adoption of the CSA practices has been slow (Kempi &Volpi, 2008). This may pose a major threat because of the limited timeframe that the world has to deal with climate change and how faster its impact is spreading. There is therefore a need to understand the barriers to adoption so that the information can help in designing and implementing interventions that can help overcome those challenges. Attention now has turned to research and policy on CSA to ensure increased and successful adoption and diffusion of these CSA innovation technologies.

2.2 Demand and Supply of Agricultural Credit

Production of food crops in Africa is faced with several challenges including weak land tenure system, limited irrigation facilities, climate variability, shrinking arable land caused by land

degradation and urbanization, and deteriorating soil fertility caused by continued use of the farms (Omboi, &Wangai, 2011). Uncertified planting materials, poor marketing and distribution system, low access to credit facilities, and high cost of agricultural inputs have compromised farmer's preparation and successful planting and harvesting leading to reduced yields. During cultivation and growing of crops, farmers need to weed and apply fertilizer to ensure high crop production. According to Hossain (1988) during planting farmers needed credit facilities to facilitate the acquisition of fertilizer and other related weeding equipment and labour. There is also a growing recognition of the fact that institutional credit is increasingly becoming an integral part in modernizing agriculture (ibid). Agricultural credit is defined as loans given to farmers to assist them in buying farm inputs, certified seeds and for use as capital investment in the farm to carry out different farming processes among other uses (Dethier & Effenberger, 2012). As the name suggests, these credit facilities are confined to agricultural development.

Technological changes are critical in managing crops to ensure maximum yield. When farmers adopt new farming technologies, they increase the demand for labour and other labour-intensive entrepreneurial activities that further create the demand for credit facilities to enable successful planting and harvesting processes. Farmers, therefore, need to embrace credit facilities that enable them to improve crop sustainability and increase the prospects of achieving the expected yields. Yawson et al., (2010) asserted that the availability of subsidized fertilizers to smallholder farmers and access as influenced by credit facilities was associated with the frequency of use and ultimately changes in farm food production. Credit facilities, especially loans, are also said to influence how farmers access agricultural extension services that further influence the outcomes of their farming experiences. It is clear that there is high demand for credit to finance farm

operations, adoption of better farming technologies and other agricultural needs but the extent to which individual factors influence the demand is not known. Also access and supply of credit, especially from formal sources do not match the demand and farmers then opt for informal credit.

It is believed that demand for credit by smallholder farmers outstrips supply. This presumption implies that most rural households exhibit positive demand for loan facilities, but the lending institutions normally determine participation in the loan market. As a result many studies both theoretical and empirical have focused on the supply side constraints with little emphasis on the demand side (Mpuga, 2010). Several studies have been done on both access and demand for credit in different continents, regions, and countries yielding inconsistent outcomes. A study by Gurmessa and Ndinda (2017), cited that there is a substantial unmet investment demand for small and medium and micro enterprises amounting up to 80 % and 90 % respectively in Latin America and African countries. In China, several studies have shown that more than 75 % of demand for credit in the rural areas is either unmet or rationed. Similarly, Muayila, and Tollens (2012) in their study in DRC found out that an estimated 71% of the participating households had experienced some form of credit constraints or rationing. From these studies, it is evident that smallholder farmers' exhibit positive demand for loan funds but, credit limited access; rationing and participation in the credit market are popular challenges across, Asia, Africa and Latin America.

A study on fertilizer subsidy in Ghana by Yawson et al., (2010) found out that farmers needed loan funds to purchase fertilizer and prepare the field for planting. They further argued that farmers were prepared to take subsidized fertilizer if it was accessible, available, and affordable.

Also the study found that improved access through the provision of credit facilities to farmers was preferred since the majority of the sampled farmers were poor subsistence farmers who needed assistance to access necessary facilities like inputs, storage facilities, and marketing channels. During planting seasons, farmers needed credit facilities to help access fertilizer, pay for farm labour in preparation for planting season, and to acquire planting seeds.

2.3 Empirical Literature

2.3.1 A Primer on Demand

The demand of a good or service at particular time and price reflects the level of utility that consumers expect to derive from it. Individuals demand goods and services such as healthcare, credit, food, shelter etc to satisfy their wants. The concept has been used by economist but it's Alfred Marshall in 1890 in his principle of economics who developed it as he explained the idea of demand and supply curves. The demand for financial services, like other products or services, is determined by own price, the price of related goods or services, level of income, and other factors. The price for credit usually is the interest charged, and based on demand theory, when the interest rate is high the amount of credit demanded by borrowers reduces *ceteris paribus* (Paul, 2004). Demand for credit is also influenced by income level, education of the borrower, number of dependents and household size. An increase in these factors will increase the demand for credit. Distance to the lending institutions and age of the borrower impacts demand for credit negatively. This is to mean that the longer the distance and advanced the age of the borrower the lesser the demand (Dorward and Omamo 2009).

In this study credit demand is defined as the amount of money a CSA farmer is able to access and borrow to fulfill his or her household consumption and agricultural activity needs such as

buying farm inputs, hiring extra labour for farming activities and cover costs related to agriculture activity including farm preparation, planting, weeding, and harvesting. This is assumed to depend on a number of factors. Kirman, (2006) pointed out that the quantity a consumer wants to buy depends on many factors including tastes and preferences, which may depend on age, sex, education or religion and the price of the commodity. Blandon et al., (2009) argued that close substitutes and compliments affect the amount of a good purchased like credit, for example, a consumer has to decide whether to borrow from formal commercial institutions, formal government subsidized institutions, or from informal credit markets. If one cannot afford to borrow from formal sources, then they opt for informal markets and vice versa.

2.3.2 Factors affecting Demand for Credit

According to (World Bank, CIAT, 2015) One of the major challenges that is faced by smallholder farmers is access to financial instruments. However, this problem is mainly on supply side of credit and includes impediments such as stringent and unfavorable policies like rationed loan amounts, cumbersome application processes and limitations in terms of credit use or its purpose. Majority of commercial lenders make assumptions about the poor farmers that they are unable to save adequately; thus their interest levels are somehow sensitive to their credit demand. Farmers' incomes are also uneven, and this affects the level of interests they are likely to be charged from their savings. Lack of savings is associated with reduced chances of accessing credit from banks. Lenders also have low trust for peasant farmers in having the capacity to repay the loans given. Majority of farmers prefer to store their savings in the form of household assets like livestock (cows, goats, chicken), land as opposed to saving in banks to increase their credit scores (Mpuga,2010). Markets rates, therefore, discourage farmers who see

the loans as expensive to pay. Farmers, especially women, have resulted in having informal savings inform of *chamas* or merry-go-rounds where members in a group contribute to save and then access the savings as wholesome once their turn comes or use the savings as collateral for loans.

Smallholder farmers prefer short-term small amounts of credit as opposed to large amounts and long-term lending preferred by formal lending institution (Schmidt and Kropp, 1987). According to Swain (2007) limited empirical evidence exists on the factors that influence demand for agricultural credit. Atieno (1997) argued that there had been a failure in correctly identifying the credit needs of the rural farmers and as a result most credit programs that have been used for rural development in many developing countries have not had much success. Schmidt and Kropp (1987) cited that lending policies of an institution influence credit access. Farmers or borrowers will not qualify or apply for credit if the duration and terms of payment and security requirements do not fit their needs.

Dorward and Omamo (2009) cited that socio-economic characteristics and institutional factors influence the demand for financial services. The level of income of the household, the size of the household, education, age, marital status, gender, occupation and farming experience, agricultural extension services, bank accounts (or saving culture), and group membership (e.g. *chamas*) are some of the factors that influence demand for financial services. In addition, Bigsten et al., (2003), using a multicounty dataset and probit model, cites that the cost of borrowing from credit sources in emerging markets differ in certain aspects such as information asymmetry, collateral, risks , distance to lending institutions, and credit transactions. A study by Atieno (1997) analyses the significance of institutional lending terms and conditions in determining

farmers demand for credit using farm level cross-sectional data from Nakuru district of Kenya and cites that income level, distance to credit sources, credit history and assets endowment influence borrowing decisions for rural farmers. Hussien (2007) using farm household survey data from Ethiopia in 2005 and stochastic frontier analysis and limited dependent variable econometric tools also cited that some of the reasons why farmers prefer credit from informal sources as opposed to formal sources are that informal sources are more flexible in terms of loan repayment.

According to Miller and Ladman (1983), on a study on factors impeding credit use in smallholder farmers in Bolivia, cites farm households who constantly borrow are seen to have higher resource base, higher household incomes, large farm size, higher education levels, greater use of improved technology higher level of market integration, a large number of cattle, larger operating costs and investments, and higher risk ability. A study in Egypt by Mohieldin and Write (2000), using primary data and probit models, cite that total assets, educational level, ownership of land, and sizes of the household influence borrowing decisions. Assefa (1989) found out that Men tend to borrow more from the formal and semiformal sources than women do.

The complexity of risks and uncertainties faced by farming communities complicate their decision to borrow (Muayila, and Tollens, 2012). According to Swain, (2007), using household data in India and a type 3 Tobit model, farmers faced with poor access to markets, limited access to new technological innovations, little or no access to support services and low return on capital are those who are located in areas with poor infrastructural facilities and usually own small and fragmented land plots which can affect their credit demand negatively. Atieno, (2001) on a study

on the role of institutional lending policies among formal and informal credit institutions in determining the access of small-scale enterprises to credit in Kenya identified several factors that tend to influence the farm household borrowing decisions negatively. Some of these factors include; limited or lack of viable enterprise to finance, poor support services, farming and markets risks, poor infrastructure, frail entrepreneurship capacity, lack of collateral and other credit requirements, lack of desirable loan qualities (credit duration, loan amount and repayment), and high costs of borrowing .

Some studies have argued that the main problem faced by the poor rural farmers is lack of access to credit but not the high interest charged. A couple of empirical findings have shown that interest rates charged affect the credit demand negatively. Studies done in the Philippines Chandra et al., (2017), on analysis of Gendered vulnerabilities of smallholder farmers to climate change in conflict-prone areas using focused group interviews, Ghana by Akudugu, (2012) on a study on determinants of farm credit using data from 250 respondents and logit and Tobit models, and Ethiopia by Girma and Abebaw, (2015) cited that increasing the borrowing rates reduced demand for credit. Nevertheless, a study from Kenya (Atieno, 1997) on the effects of institutional factors on credit demand by farmers found no significant association between interest and loan demand. In Ethiopia, high transaction costs, in general, had a negative influence the demand for formal credit (Grime and Abebaw, 2015).

Distance to the lending institutions in many cases was cited to negatively influence demand for credit. Studies on factor analysis on loan demand using Tobit model (Akudugu, 2012; Jianqiang, & Bing, 2008) cited that there exists a negative and significant relationship between distance to

the credit institution and loan demand. It is expected that this relationship is negative because it is directly related to information asymmetry, credit costs, and accessibility as in most cases the longer the distance the more trips one has to take, more time one has to spend etc.

Education level is believed to influence credit demand positively; however, some studies have found some inconsistencies. Studies in Kenya (Mensah, 2014), Nigeria (Akpanet et al., 2013), Ethiopia (Girma and Abebaw, 2015), China (Rui and Xi, 2010), Uganda (Mpuga, 2010), and Ghana (Akudugu 2012) found that education level affected credit demand positively. However, another study from China by Jianqiang, & Bing (2008) showed that education had a negative influence on credit demand. Wiboonpongse et al., (2006) found no significant relationship between education level and credit demand in Thailand. Despite the inconsistencies, overall studies have shown that education is among the key variables that influence the borrowing decision.

Age is believed to have an inverse relationship with demand as it is thought that as age advances farmers will demand less of credit. However studies carried out in Uganda (Mpuga, 2010) and Nigeria (Akpanet al., 2013) found out that there is a positive relationship between the age of the household head or farmer and credit demand. This could be attributed to the fact that older farmers are more likely to have more assets like land which they can use as collateral. However, a study by Jianqiang, & Bing (2008) in China found out that age had a significant negative influence on credit demand. Other studies in Ethiopia by (Girma and Abebaw, 2015) and (Swain, 2007) in India found no statistically significant relationship between credit demand and age.

Gender of the household head or the farmer is another major factor that influences demand for loans. According to studies by Girma and Abebaw, (2015) in Ethiopia and Mpuga, (2010) in Uganda, women are less likely to borrow from formal institutions. However according to Akudugu (2012), men seemed less likely to demand for credit in Ghana. Gurmessa & Ndinda, (2017) found no significant relationship between gender and loan demand in Ethiopia. This means the relationship between gender and loan demand is region specific. Farm size is another factor that influence demand for credit facilities. Studies in Ethiopia by (Girma and Abebaw, 2015) China (Jianqiang, & Bing, 2008), India (Swain, 2007), Kenya (Atieno, 1997) and Ghana (Akudugu, 2012) found out that farm size has a positive influence on loan demand. This could be because farmers with large farms may need loans to finance large farming operations and could use their farms as collateral to access loans.

Schools fees and medical expenses also influence demand for credit. According to Girma and Abebaw (2015) in Ethiopia and Jianqiang, & Bing (2010) in China, spending on school fees and medical expenses affected household decisions to borrow positively. Similarly, a study by Jianqiang, & Bing (2008) in China found out that production and management expenditure had a positive influence on loan demand. Another factor that is expected to have an impact on loan demand is household size. Swain (2007) in India found that household size influenced demand for credit positively. In Kenya, Messah, (2011) and Mpuga, (2010) in Uganda found that family size and loan demand has a negative relationship.

Off-farm income is also expected to influence loan demand although it has exhibited varying results in different studies. According to Girma and Abebaw (2015), there was a negative

influence of non-farm income on loan demand in Ethiopia; while Jianqiang & Bing (2008) found a positive relationship in China. Girma and Abebaw (2015) in another study in Ethiopia, and Atieno (1997) in Kenya found no significant correlation between non-farm income and loan demand. Studies by Jianqiang, & Bing (2008) and (Mpuga, 2010) cited that asset value and net worthy impacted demand positively. Farmers with high net worth and who own a lot of assets tend to exhibit high demand for loans because they can provide collateral for the loans and need more financial power to carry out their operations.

2.3.3 Demand for credit and CSA practices

Climate-smart agriculture (CSA) practices include sustainable agricultural practices, profitable agricultural ventures among others. According to Ojoko et al., (2017), using cross sectional data from 120 rural households and ordered probit regression model there are several factors that affect the level of use, adoption and diffusion of climate smart agriculture practices (CSAPs) among farmers. These authors opined that farmers with lower levels of income will adopt CSAPs if they have access to credit. They found out that when farmers have access to credit, they are able to afford more smart farming technologies that wound be otherwise expensive to acquire with their incomes. Again the low CSAPs user/adopters will increase their adoption if they have access to loan funds. The demand for credit facilities to engage in CSAPs is also influenced by the information farmers have on the benefits of the climate-adaptive agriculture.

Another study in Nigeria by Amau and Ayantoye (2015), found out that access to loan funds by the farming households can be used to increase production via the purchase and use of modern farming technologies and certified planting materials. Akudugu et al., (2012) in his study on

Adoption of modern agricultural production technologies by farm households in Ghana cited that access to credit is one of the influencing factors for farmers to adopt modern farming technologies and thus poor rural household who also lack access to credit find it hard to access smart farming technologies. Meybeck and Gitz (2013) insists that governments, NGOs (non-governmental organizations) and other community-based organizations need to be informed of the benefits of CSA and the climate change mitigation practices. Sharing of information to the farmers is likely to create demand for, and consumption of credit facilities made for improving climate-smart agricultural practices. Thus the importance of credit access in influencing the adoption of smart farming technologies cannot be underestimated.

2.5 Chapter summary

The literature review identified categories of factors affecting credit demand including institutional It also identified individual factors that influenced demand for loan facilities like age, education, gender of the household head, farm size, and farming experience. The other identified category of factors dealt with socio-economic determinants including income levels of farmers, occupation, belonging to a social group/*chamas*, and the type of information shared among the farmers. The literature review tried to establish the credit facilities needed across a farming calendar where it was identified that farmers required credit facilities during farm preparations where they purchase fertiliser, farm labour, and agricultural extension services as well as during harvesting seasons.

From the literature, it is evident that Credit demand is influenced by categorized factors like institutional factors, individual factors, social-economic and the CSA practices embraced. Also

most studies have tried to model demand and access combined and thus used probit, Tobit, or logit models while a few used double hurdle model to model separately farmers credit market participation and the intensity of participation. Also, the extent of the adoption and diffusion of CSA practices is not known in sub-Saharan Africa as very limited literature exist.

CHAPTER THREE: METHODOLOGY

This chapter presents the methods and procedures used in this study. It includes the description of the study area; data types, needs and sources, sampling procedure and sample size determination, questionnaire design and data collection, conceptual framework, theoretical model and the empirical model.

3.1. Study Area

The study was carried out in Nyando basin covering part of Kericho and Kisumu Counties in Western Kenya (see Figure 1). This area consists of humid and sub-humid zones with rainfall of about 900-1200 mm spread over two rainy seasons (ICRAF, 2008). It is characterized by land degradation majorly from soil erosion and water runoff which cause the formation of deep gullies that have affected about 40% of the landscape (Ibid). The area has been experiencing increased weather variations with severe droughts and floods that have affected agricultural production and food security (Förch et al., 2013). Poverty levels are high (over half of the population live below the poverty line) and diseases including HIV are also prevalent. The primary source of livelihood for the locals here is mixed farming which is done on farm sizes of less than one hectare. For the past decade, nothing much has changed in terms of agricultural practices as farmers still practice mono-cropping, poor crop husbandry, little or no conservation agriculture, keeping traditional low yielding livestock varieties among others, in most households, and this has resulted in dwindling agricultural productivity. As a result, food security and nutritional status of most households is compromised as they cannot meet daily dietary needs all year round and experience at least a month of hunger. In Nyando maize, sorghum, millet, groundnuts, sugarcane are the main crops, and livestock kept here are local breeds with some areas having dairy cows.

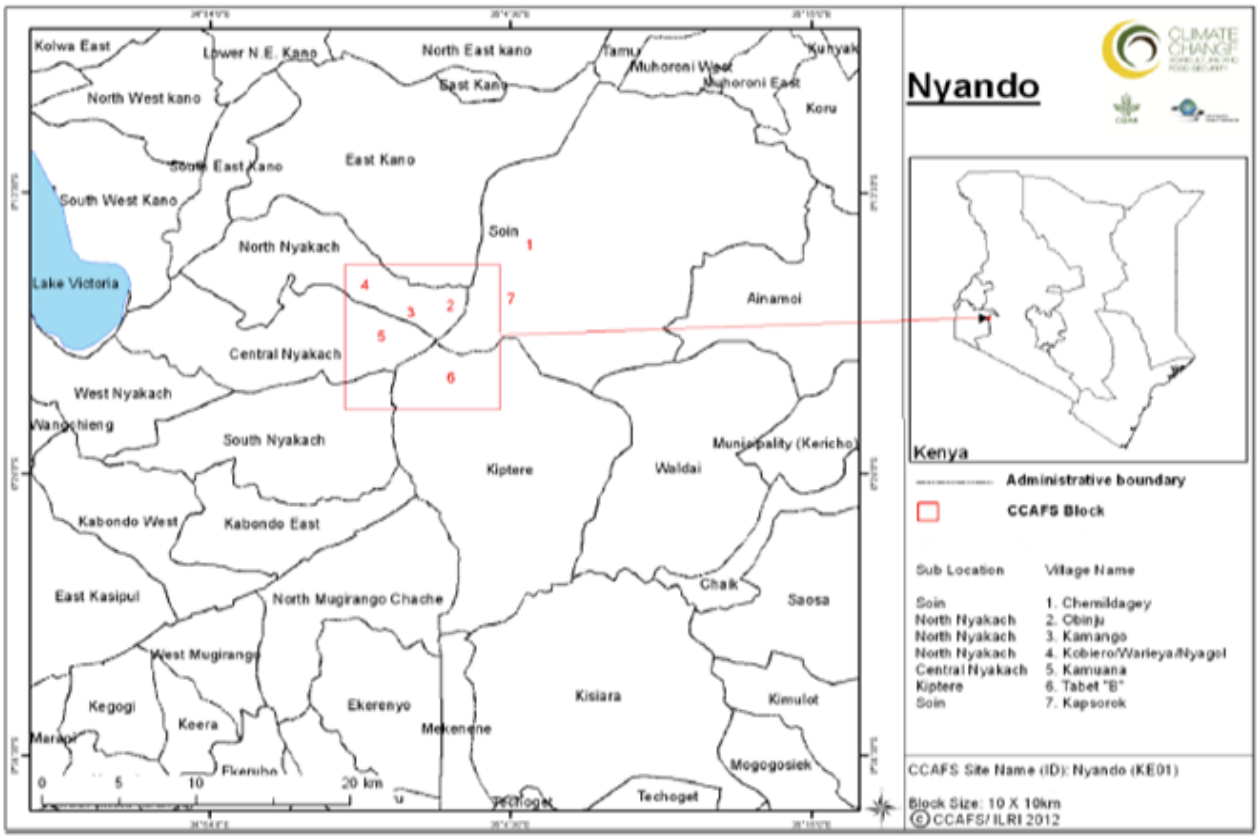

Figure 1: The map of the study area

Source: Climate Change Agriculture and Food Security Site Atlas, Nyando

3.2. Data Needs, Types and Sources

To achieve its objectives the study used primary data obtained through a household baseline survey. Data on household characteristics, demography, socio-economic aspects, household financials, borrowing and social capital was collected and used for the analysis.

Based on the study design primary data was ideal and Nyando basin was selected as the ideal area of study as already there is a CSA pilot program underway.

3.3. Sampling and Sample Size Determination

Stratified random sampling was used to sample 120 households using the 2017 CCAFS end line survey. This survey had 216 participating households in the CSVs and 217 non participating households in non-CSVs. The sampling procedure used the following variables to come up with the strata: a) Location (household is located in CSV and household not located in CSV), b) household ownership of sheep/goat (household has no sheep/goat, household has only indigenous sheep/goat and household has improved sheep/goat) and c) Crop and land management practice by household (low / high) -household practices low crop/land management, that is, no improved seeds / no fertilizer / no pesticides ('low crop management') and did not stop burning / introduce intercropping / introduce ridges or bunds / introduce terraces / introduce hedges / planted below median number of trees per acre, in past 10 years ('low land management') and Household practices high crop/land management otherwise. This creates 2 by 3 by 2 = 12 different strata. The sample was divided into two groups; the treated households (CSVs) and the untreated households (Non-CSVs).The non-CSVs were sampled from a distant village to avoid contamination but had the same observable characteristics like climate, soils, and agricultural practices as the treated group. This is illustrated in table 1

Table 1: Frequencies of households across strata in 2017 CCAFS End line Survey

Strata (1)	Location (2)	Ownership of goats/sheep(3)	Crop/land management(4)	Population frequency(5)	Target frequency(6)
1	CSV	None	Low	9	10
2	CSV	None	High	18	10
3	CSV	Indigenous	Low	35	10
4	CSV	Indigenous	High	87	10
5	CSV	Improved	Low	18	35
6	CSV	Improved	High	47	35
7	NO CSV	None	Low	26	5
8	NO CSV	None	High	18	5
9	NO CSV	Indigenous	Low	73	5
10	NO CSV	Indigenous	High	55	5
11	NO CSV	Improved	Low	4	5
12	NO CSV	Improved	High	4	5

*CSV-climate smart village

Column 6 in Table 1 shows the targeted number of households selected from each stratum. Given that the research is focusing on up scaling of existing interventions in CSVs, the sampling intentionally focused primarily on households located in the CVSs. Still, we included households not located in CSVs in order to increase the external validity of the results. Therefore, about 75% of the sample is drawn from the households located in CSVs, and the remaining sample from households not located in CSVs. For households located in the CSVs, we oversampled the strata with households owning improved goats/sheep (strata 5 and 6) because of our focus on improved livestock as a scalable intervention that has proven to be successful. Strata 1 and 2 with relatively low frequencies are also oversampled in order to facilitate statistically meaningful comparisons within these strata. In situations where the actual frequency was less than the target then all households in that stratum were selected.

Table 2: Frequencies of households across strata in the Baseline Survey

Strata (1)	Location (2)	Ownership of goats/sheep(3)	Crop/land management(4)	Sample frequency(5)
1	CSV	None	Low	6
2	CSV	None	High	11
3	CSV	Indigenous	Low	11
4	CSV	Indigenous	High	10
5	CSV	Improved	Low	17
6	CSV	Improved	High	36
7	NO CSV	None	Low	6
8	NO CSV	None	High	4
9	NO CSV	Indigenous	Low	3
10	NO CSV	Indigenous	High	5
11	NO CSV	Improved	Low	4
12	NO CSV	Improved	High	4

As a result of the oversampling of some strata as well as because some households could not be found or refused to cooperate, sampling weights have been constructed to make the data representative of the 2017 CCAFS end line survey. The households in CSVs were randomly selected from seven sub locations and included Kapsorok, Jimo East, Kapkara Awach, Kaplelartet, Lekwenyi and Agoro East. The control households were selected from five sub locations and included, Kamasega Olembo, Simbi, Kabodho East, and Kaplelartet.

3.4. Questionnaire Design and Data Collection

The study used structured questionnaire to collect the required data at the household level for analysis. The questionnaire contained selected questions aimed at gathering the relevant household data and information. It included sections on respondents' information, .household

demography, community groups, loans and borrowing aspects, savings, household assets and land ownership and use. Primary data both qualitative and quantitative was collected using open data kit application (ODK) through a baseline survey from sampled farm households both male and female headed, in Nyando basin through a one on one interview. The data was collected by university of Nairobi masters students in conjunction with CCAFS. The study questionnaire was piloted to test the appropriateness of the questions to the target population, to test if the results will fulfill the purpose of the study and identify any possible errors that could affect the results.

3.5 Data Analysis

The data was saved in a central server where it was extracted in excel format. It was then imported to STATA where cleaning, variable selection, labeling and naming was done for analysis. The analysis included descriptive statistics and regression analysis.

3.5.1 Analytical Framework

This section discusses theoretical framework used and illustrates the conceptual framework for the research paper.

3.5.2 Theoretical Framework

According to Verbeek (2004), in binary dichotomous models, individuals have to make decision whether to act or not to act. In this regard individuals' decisions are random and might be affected and influenced by certain factors. The probability therefore is bounded by zero and one that is described by a cumulative probability distribution function. When this distribution is normal it gives a probit model.

Econometrically probit model is commonly used in describing binary choices, for instance, a consumer who makes a choice to buy particular product or not or a farmer who makes a decision

on whether to adopt a certain technology or not. Several systematic factors together with individual's unique characteristics might influence this outcome, which we denote by λ. The systematic influences affecting the outcome of consumer i can be represented as by the function;

$$\xi_i = \xi(x_{1i}+, \ldots . + x_{ni}) \qquad (1)$$

which may be a linear combination of variables. The individual unique (idiosyncratic) influences can be expressed by a normal stochastic variable (ε_i) with a mean zero. Consumer i will therefore give a positive response $y_i = 1$ if the systematic influence ξ_i exceeds his/her own threshold value, $\lambda_i \backsim N(\lambda\, \sigma^2)$, otherwise there will be no response i.e. $y_i = 0$. The individual threshold λ_i is assumed to deviate randomly from the global thresholdλ. Therefore,

$$y_i = \begin{cases} 0 \;\; if \;\; \lambda_i > \xi_i \\ 1 \; if \; \lambda_i \leq \xi_i \end{cases} \qquad (2)$$

The probability statements of these expressions are expressed as;

$$P(y_i = 0|\xi_i) = P\left(\frac{\lambda_i - \lambda}{\sigma} = -\varepsilon_i > \frac{\xi_i - \lambda}{\sigma}\right) \qquad (3a)$$

$$p(y_i = 1|\xi_i) = p\left(\frac{\lambda_i - \lambda}{\sigma} = -\varepsilon_i \leq \frac{\xi_i - \lambda}{\sigma}\right) \qquad 3(b)$$

Where P is the probability of the outcomes and$\varepsilon_i \sim N(0,1)$. If the systematic function$\xi = \xi(x_1+, \ldots . + x_n)$, then the probability functions can be expressed as;

$$P(y_i = 0) = P(0 > y_i^* = \beta_0 + \beta_1 x_{1i}+, \ldots, +\beta_k x_{ik} + \varepsilon_i) \qquad (4a)$$

$$P(y_i = 1) = P(0 \leq y_i^* = \beta_0 + \beta_1 x_{1i}+, \ldots, +\beta_k x_{ik} + \varepsilon_i) \qquad (4b)$$

where,

$$\beta_0 + \beta_1 x_{1i} +, \dots, + \beta_k x_{ik} = \frac{\xi(x_{1i} +, \dots . + x_{ni}) - \lambda}{\sigma} \qquad (5)$$

The βs are parameters to be estimated; x_s are explanatory variables of the model; and ε is the random error term. Using the appropriate normalizing transformations, it is possible to convert the original statements relating to the normal distribution $N(\lambda_l, \lambda\, \sigma^2)$ to equivalent statements expression in terms of standard normal distribution$N(\epsilon_i; 0,1)$. To use the model on individual data responses that is indexed by $i = 1, \dots, N$ the probability values can be obtained by;

$$P(y_i = 0) = 1 - \pi_i = \Phi(\beta_0 + \beta_1 x_{i1} + \cdots + \beta_k x_{ik}) \qquad (6)$$

Assuming a sample observation for y and x i.e. (y_i, x_i); $i = 1, \dots, N$, where $y_i \in \{0,1\}\, \forall i$; and that the events affecting the individuals are statistically different and are expressed as $\pi_i = \pi(x_i, \beta)$ to represent the probability of an event affecting individual i. The likelihood for this sample can be written as;

$$L(\beta) = \prod_{i=1}^{N} \pi_i^{y_i} (1 - \pi_i)^{1 - y_i} = \prod_{i=1}^{N} \left(\frac{\pi_i}{1 - \pi_i}\right)^{y_i} (1 - \pi_i) \qquad (7)$$

Which is the product of n point binomials whose log likelihood function is given as;

$$Log\ L = \sum_{i=1}^{N} y_i\, log\left(\frac{\pi_i}{1 - \pi_i}\right) + \sum_{i=1}^{N} log(1 - \pi_i). \qquad (8)$$

3.5.3 Conceptual Framework

The conceptual framework highlights the factors that influence the decision that households take in the process of demanding for credit. A household will only demand for credit if there is a need or a want they need to address and their regular income falls short thus creating a financial gap. The decision whether to apply for credit after identifying their financial gap will be determined by a number of factors some which include gender and age of the household head, wealth endowment, and ability to produce collateral among others. Some farmers after analyzing the requirements of the credit market will opt out while others will proceed to apply for credit. Those who apply might either secure or be denied depending on whether they meet the criteria laid down by the credit givers. There are again factors that dictate the amount given to those applicants who are successful. The amount secures might be influenced by the same or different factors as the decision to participate in the credit market. Those who seek to participate in the credit market are aiming to access financial service to increase their productivity, enhance food security, and diversify their incomes and better there welfare. The chart below highlights diagrammatically the process of credit demand.

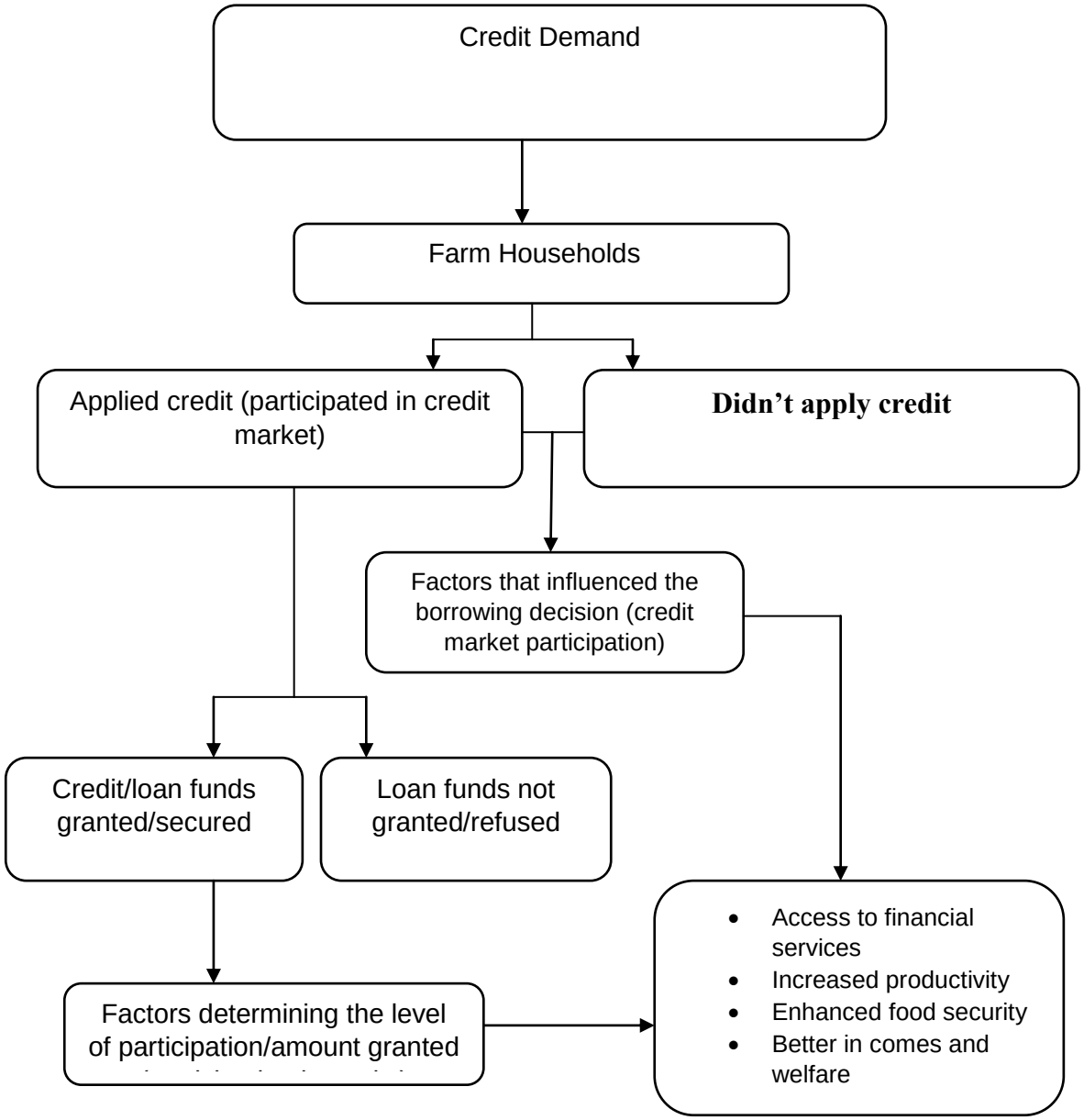

Figure 2: Conceptual Framework

Source: authors own construction

3.6 Empirical Model Specification

Tobit model has been commonly used in studies analyzing the factors influencing borrowing decision and intensity of participation assuming that the same sets of factors affect the two stages (Greene, 2007). However, normally, the decision on whether to participate and extend of participation can be jointly or separately made. In a case where the decision is jointly made the Tobit model is the most suitable (Greene, 2007; Teklewold et al., 2006). A lot of previous works on factors influencing demand for loan funds have used this assumption.

Borrowing from Cragg (1971), Moffat (2005) and Kefyalewet et al., (2016) the study used double hurdle model and maximum likelihood estimation technique. This model overcomes the weaknesses of the both Heckman selection and Tobit models of assuming once the first stage has been passed there are no zero observations in the second stage and being too restrictive, that is, the same set of variables affect the two decisions respectively (Beshir, 2013; Tura, 2010).

This study assumes that the credit market participation decision precedes the amount of loan demanded by a farm household and the factors influencing each might differ (Gebremedhin and Swinton, 2003). In such a case double hurdle becomes the most appropriate model to use whereby a probit regression is followed by a truncated regression on the non-zero observations for decision to borrow and amount borrowed respectively (Cragg, 1971). According to Cragg, (1971) the Tobit model has a weakness of attributing the censoring to a standard corner solution thereby assuming that non-borrowing is attributed to economic factors only .

The double-hurdle model is a generalization of the Tobit model, in which two separate independent processes determine the decision to borrow and the level of participation (Greene, 2007; Gebremedhin and Swinton, 2003).It is applied in a manner that, the two hurdles have equations associated with them, taking in the effects of farmer's characteristics. According to Moffat, (2005), the independent variables may be found in both equations or in either one, however, a variable occurring in two equations might have opposite effects. The double-hurdle (Cragg, 1971), assumes that farm households make two decisions with regard to the decision to participate and level of participation. Each hurdle is guided by the household's socio-economic characteristics. A different latent variable is therefore used to model each decision process.

This process entails running two regressions. The first is the probit model regression to identify determinants of credit market participation (decision to borrow) by all the 122 farm households in Nyando. Then the second stage involves running a truncated regression for those farm households who participated in the market and secured credit to analyze the factors affecting the amount of credit secured.

From Cragg (1971), Moffat (2005), Getachew & Nego (2016) and Kefyalewet al, (2016) the two hurdles can be expressed as:

$$b_i = \alpha \boldsymbol{z_i} + v_i \qquad (9)$$

$$y_i = \beta \boldsymbol{x_i} + \varepsilon_i \qquad (10)$$

where; $\boldsymbol{z_i}$ is a vector of explanatory variables for borrowing decision; $\boldsymbol{x_i}$ is a vector of explanatory variables influencing amount of loan secured/received, while v_i and ε_i are error terms. Equations 1 and 2 are assumed to be independent and the error terms are random and

independently distributed; $v \sim N(0,1)$, $\varepsilon \sim N(0, \sigma^2)$. The likelihood function of this model assumes that the probit and truncated regressions are uncorrelated. This function can be expressed as:

L_{DH}

$$= \prod_{y_{i=0}} \left[1\Phi(Z\alpha_i, X\beta_i \frac{1}{\sigma, \rho} \right] . \prod_{yi>0} \left(\Phi \left(ZX + \frac{\rho}{\sigma}(Y - XB) \right) \Big/ \sqrt{1 - \rho^2} \right) \frac{1}{\sigma} \ \emptyset \left[\left(Y - XB \Big/ \sigma \right) \right] \quad (11)$$

Where, Φ is the standard normal cumulative distribution function, while $\emptyset$ is the Normal density function. We use maximum likelihood estimation technique to estimate the likelihood function. Equation 3 above can be reduced to likelihood function for the independent double hurdle model

$$L_{IDH} = \prod_{yi=0} \left[1 - {}^{\Phi}(Z\alpha)^{\Phi} \left(\frac{XB}{\sigma} \right) \right] . \prod_{yi>0} \left[{}^{\Phi}(Z\alpha) \frac{1}{\sigma} \emptyset \left((Y - XB) \Big/ \sigma \right) \right] \qquad (12)$$

Now the analytical model for the study can be specified as:

a) First hurdle (credit market participation decision) - the probit regression

$$p_{rB} = \beta_0 + \beta_i \boldsymbol{x_i} + \varepsilon \qquad (13)$$

Where, p_{rB} is the probability of a farm household in Nyando requesting for credit or funds; β_i are parameters to be estimated; $\boldsymbol{x_i}$ are explanatory variables expected to influence the borrowing decision; and ε is error term.

b) The second hurdle (amount of credit) –truncated regression. The underlying latent variable has the following relationship.

$$y_i^* = \beta_0 + \beta_i \boldsymbol{z_i} + \mu_i \qquad \mu_i | z \sim N(0, \sigma^2) \qquad (14a)$$

$$y_i = \begin{cases} y_i^* & if \;\; y_i^* > 0 \\ 0 & otherwise \end{cases} \qquad (14b)$$

Where, y_i is observed amount of credit received by the i-th farmer; β_i are parameters to be estimated; z_i are explanatory variables determining credit received; and μ_i is the error term. The variables used for the study are:

Dependent Variable (y_i)

The depended variables for the study are decision to borrow loan (binary variable) with 1 or 0 and; amount of loan funds that individual farmers have borrowed (continuous variable). It was obtained from the responses by the farmers.

Explanatory Variables

Gender of the household head (GE): Gender of the household head is a dummy variable assuming the value of 1 if the responded is a male and 0 otherwise. Women are considered disadvantaged especially in the rural areas because most do not have rights to property especially land hence they have challenges accessing credit. This might reduce their demand for loan funds. This study expects a positive relationship between loan demand and male headed households. The influence of group membership might also have a positive influence on loan demand. Since most of the group members are women, this might give a different outcome that women headed households might be borrowing more.

Number of Groups: This is the number of groups household members from a particular household belong to. The more the groups the ease of accessing credit. Groups are a form of social capital and through them farmers have access to information and mentorship. It is expected that it will influence credit demand positively.

Wealth Index (WI): Wealth index is a gauge of a household's collective living standards. It is computed using data on household's possession of certain set of assets: televisions and bicycles, housing construction materials, and water access and sanitation facilities among others. It is computed using principal components analysis by summing up five categories of capital: natural capital that comprises of total land size owned and cultivated farm size by a household; physical

capital which includes assets like bicycles, motor vehicles, motor bikes wheelbarrows etc.; human capital which is represented by household labor capacity; social capital (group membership); and financial capital . A weighted average of all the above represents the household wealth endowment.

Age of the farm household head (AG): This is the number of years the farm household head has lived as at the time of the research interview. Age is attributed with more accumulated assets, experience and wealth. Farmers with high endowment of assets tend to show increased loan demand since they can provide the collateral needed. However older people might tend to be risk averse and sometimes might show low demand for loan funds. The expected relationship is therefore indeterminate.

Education level of the farmer (EDUC): This is defined as the number of years of formal schooling of farm household head. Farmers with more years of schooling are expected to have access to more information and knowledge about new farming technologies, how to access formal credit among other aspects. The more educated a farmer is, the more it is expected they will exhibit increased loan demand.

Investing in Climate-smart practices/technologies (CSAPs): Climate-smart technologies are associated with increased productivity. However, climate-smart technologies are expensive and require funding especially for poor smallholder farmers. Thus, it is expected that farmers exposed to CSA exhibit increased loan demand to invest in these technologies. However more interventions might mean that the farm household has diversified income sources and might not require loans to offset its financial needs. This variable is assumed to have a positive influence on decision to get loan and also the loan amount.

Collateral (group shares): Collateral is expected to have positive influence on demand. Farmers with large tracks of land and are wealth endowed including social capital can afford to provide collateral to access loans. However, in Nyando most farmers borrow from groups and use their shares in those groups as collateral. It is expected that group shares have a positive influence on credit demand among these farmers.

Household savings: This is a dummy variable assuming the value of 1 if the household saves and 0 otherwise. From literature, Savings have both positive and negative influence on credit demand. A household with more savings may not demand for credit as they can use their savings to finance farm operations and other household financial needs. However savings might also act as a security for credit and more savings might lead to more credit as the household has the capacity to repay.

Primary occupation: It's a dummy variable assuming 1 if the household head primary occupation is agriculture related (rearing animals and crop farming) and 0 otherwise. It's expected that farmers practicing agriculture as their main occupation will need to increase productivity and thus may seek for credit to do so. Agricultural production is a risk occupation full of uncertainties and irregular outcomes and this might be a discouragement to farmers to seek for credit to invest in their production.

Household size: This is the total number of people in household who live and eat together. The more members in a household the more financial needs they have such as school fees, health expense etc. This is expected to influence demand for credit positively.

Loan repayment period: The duration over which a farmer is required to repay a loan plus its interest. It's expected to influence credit demand positively if the repayment period is long and

negatively if very short. If the repayment is well spread and flexible, then credit demand might increase.

Table 1 below shows the dependent and independent variables that are hypothesized to determine the demand for credit by smallholder farmers in Nyando and their expected signs.

Table 3: Variable description and measurement

Variables	Notation	Type	Measurement unit	Expected sign
Dependent variable				
Demand for credit	Y	Continuous and dichotomous		
Explanatory variables				
Age of the HH head	AG	continuous	No. of years lived	+/-
Education of HH head	EDUC	Categorical	Number of Years	+
Gender of HH head	GHH	Dummy	1=male, 0=otherwise	+/-
Collateral (group shares)	COLL	Dummy	1=yes,0=otherwise	+
Wealth Index	WI	Continuous	Amount of assets	+
House hold size	FS	continuous	No. of people	+
Primary occup. of HH head	PRHH	Dummy	Agriculture=1,0=other wise	+
Household savings	HHSVNG	Dummy	1=saving, 0=Otherwise	+/-
Number of groups	NGRP	Continuous	No. of groups	+
CSA Investment	CSA	Dummy	1=yes, 0=otherwise	+
Loan Repayment period	LRP	Continuous	No. of months	+/-

CHAPTER FOUR: RESULTS AND DISCUSSION

This chapter presents and discusses the study results. It is divided into two main sections: descriptive statistics of the farm households in the study and econometrics results and analysis of the factors influencing both credit market participation and intensity by the smallholder farmers in Nyando.

4.1 Descriptive analysis

The descriptive statistics gives a summary of all the variables used in the study. From Table 4, the average age of the household head is 54 years with the youngest being 25 and the oldest 94. The number of groups that household members belonged to range from 0 to 6 groups with an average of 1.7 groups per household. Loan repayment period ranged from zero to 48 months (2 years) with an average of 3.36 months. Among the 122 households interviewed the smallest household had 1 member with the largest having 14 members. The mean family size was 6 members which often lead to high dependency ratio. Number of CSA practices adopted by households ranged from 1 to 6 practices while household savings ranged from 0 to Ksh.400, 000 with an average of about ksh.13, 000.The average interest rate charged on loans was about 8 % with the highest rate being 53%.

Table 4: Summary of socio-economic and demographic variables used in modelling

Variable	N	Mean	Std. Dev.	Min	Max
Age (years)	122	54.35	16.06	25	94
No of group	122	1.75	1.22	0	6
Loan repay period (months)	122	3.37	6.41	0	48
Household size	122	5.94	2.41	1	14
Number of CSA adopted	122	1.05	1.01	1	4
TLU	122	5.69	6.80	0	63
Wealth index	122	0.00	2.65	-3.16	11.85
Household savings	122	13312.30	42182.92	0	400000
Interest rate	122	6.43	8.73	0	53

Note: Livestock are measured in Tropical Livestock Units (TLU). A TLU represents an animal of 250 kg live weight, and used to aggregate different species and classes of livestock as follows: Bullock: 1.25; cattle: 1.0; goat, sheep, and pig: 0.1; guinea fowl, chicken, and duck: 0.04; and turkey: 0.05 (Runge-Metzger 1988).

There are 23 (18.85 %) female headed households as opposed to 99 (81.15%) male headed. In addition, 77 (63.11%) household heads were married while 45 (36.89%) being either single, divorced, widowed, separated etc. Group membership is very important to the people of Nyando with 110 (90.16%) belonging to at least one self-help or a community group. Agriculture (crop and livestock farming) is the main economic activity with 74 (60.66%) household heads practicing it as their primary occupation while 48 (39.34%) engaging in other occupations like salaried work as their main occupation. Among the 71 out of 122 farmers who demanded for a loan in the years 2018, 42 (34.43%) applied and acquired it between January and June while 80 (65.57) either acquired loans between July and December or didn't apply at all (See Table 5). This shows that there is high demand at the beginning of the year which might be as a result of paying school fees, land preparation for the long rains, planting etc.

Access to formal credit by farm households still remains low in Nyando as majority of the farmers interviewed preferred community groups to formal institutions as their source of credit.

In addition, farmers preferred short term credit in small amounts and flexible repayment period. Those who had loans were required to pay within a minimum of 1 and maximum of 48 months which agrees to the findings of (Schemidt & Kropp, 1987).

Table 5: Percentage and frequency distribution of other socio-economic and demographic variables

Variable	Freq.	Percent
Gender		
Females	23	18.85
Males	99	81.15
Marital status		
Not married	45	36.89
Married	77	63.11
Group membership		
Non members	12	9.84
Members	110	90.16
Primary occupation		
Others	48	39.34
Agriculture	74	60.66
Loan seasonality		
2nd season	80	65.57
1st season(Jan-June)	42	34.43

About 8.2% households heads never attended any formal schooling, 36 (29.51%) didn't complete primary education while 34 (27.87%) completed primary school education. Those who went to secondary and didn't complete were 14 (11.048%) while 16 (13.011%) completed secondary school education. Only 1(0.82%) attended tertiary education but didn't complete with 11 (9.02%) completing tertiary/college education. Therefore farmers of Nyando are generally literate.

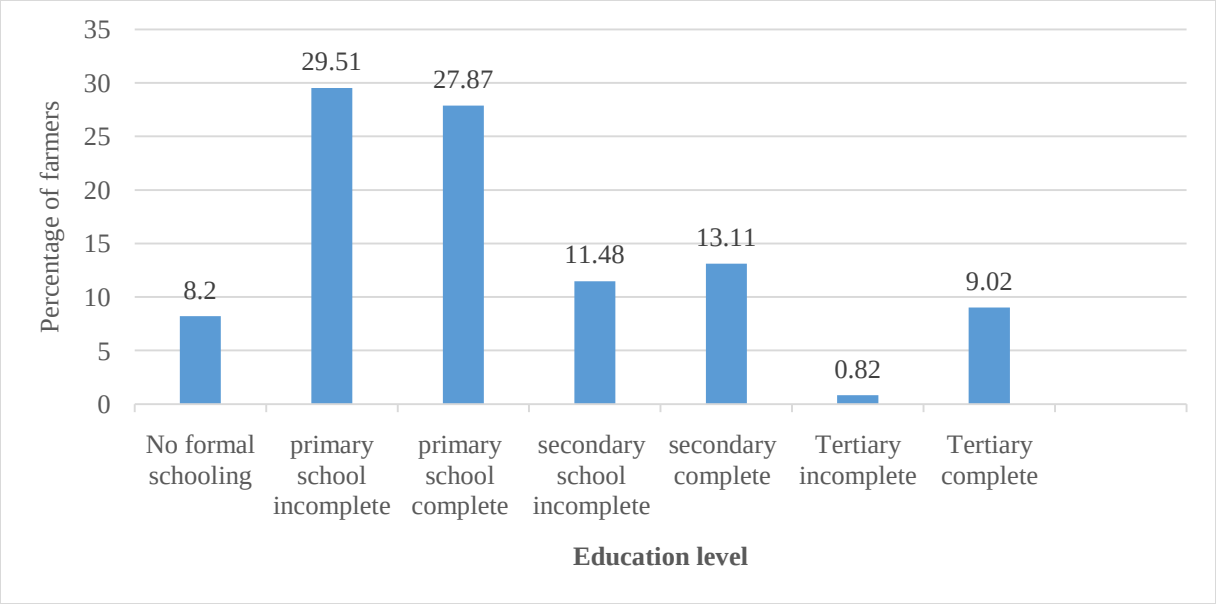

Figure 3: Graph of household head education level

4.2 Credit sources, access and use

This section discusses the kind of loan farmers' demand and for what purpose. It also includes the sources of the loans. Out of the 122 farm households interviewed, 51 (41.80%) obtained their loans from community groups where they are members, 5 (4.10%) from banks, 1 (0.82%) from a relative, 1 (0.82%) from an input supplier and 8 (6.56%) from other sources. It's evident that groups are the main sources of loans for these farmers (Table 7). It's important to note that most farmers borrowed from the informal credit market

Table 6: Sources of credit for farm households

Loan sources	Freq.	Percent
Bank	5	4.10
Relative	1	0.82
Input supplier	1	0.82
Community groups	51	41.80
Other sources	8	6.56
None	56	45.90

About 46% of the farmers didn't participate in the loan market or were not successful and thus didn't use loans for any of their activities in the year 2018 (study period) while 66 (54.10%) participated in the credit market and succeeded in securing loan funds. Among the farmers who successfully participated in the credit market, 6 (4.92%) demanded loans for food expenses (household consumption) while 3 (2.46%) households borrowed to finance health expenses, 10 (8.2%) demanded loan funds for agricultural related activities (agricultural credit) for the 2018 period, where 3 (2.46%) purchased planting seeds, 4 (3.28%) bought livestock and 3 (2.46%) invested in water catchment technologies (water pans). Out of 122, 46 households representing a 37.70% demanded loans to finance other activities other than food, health, and agricultural related activities. It is only one household that borrowed to repay another loan for the specified period (see Figure 4).

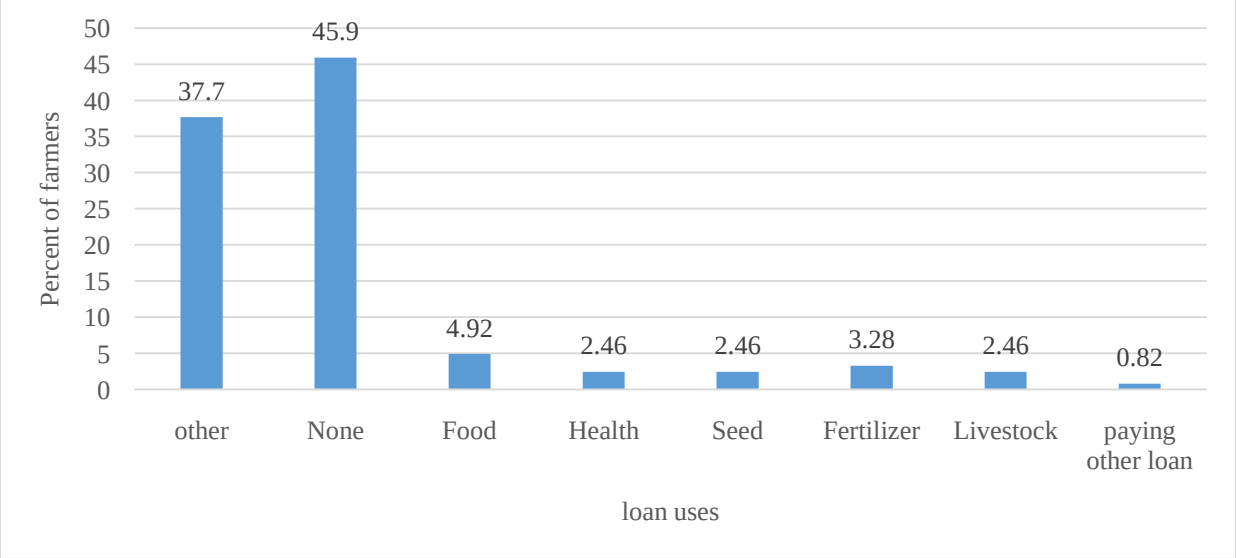

Figure 4: Graph of farmers credit use

Among the other loan uses (facilities demanded) school expenses takes the biggest portion accounting for 22 (47.83%) of all the 46 households while 4 (8.70%) demanded loan funds for both school expenses and farming activities. Those who took business loans(starting a small

business or expanding) were 5 (10.87%).These statistics indicate that school expense loans are among the highly demanded followed by agriculture and business (Table 8).

Table 7: Other uses of credit by farm households

Other loan uses	Freq.	Percent
Business and school fees	4	8.70
Buy weaving materials	1	2.17
Buying farm inputs	1	2.17
Fees and funeral expenses	1	2.17
Finance agricultural activities and helped a neighbor	1	2.17
Financing agricultural activities	1	2.17
Financing household items	1	2.17
Food, land preparation, nursery school fees	1	2.17
Grocery business	1	2.17
House refurbishment	1	2.17
Increasing business stock	1	2.17
Land lease	2	4.35
School Fees, building his house	1	2.17
School fees, farming	1	2.17
To buy household items, animal feed and food	1	2.17
Business	5	10.87
School expenses	22	47.83

Farmers also used part of the loans they borrowed to finance climate smart agricultural activities. Among 122 farm households only 18 (14.75%) said that they used part of the loans they borrowed to finance Climate smart agriculture activities like agroforestry, water catchment, greenhouse farming and rearing and cross breeding of Galla goats to improve the local breeds. The low investment through loan funds to CSA could have been caused by the interventions done by CCAFS at the beginning of the program like providing free tree seedlings and seeds, free certified seeds, Galla goats etc. From the findings we can generally see that most households demand loans for school expenses, farming activities including CSA and either starting small business or expanding the already running ones.

Table 8: Proportion of loans used for CSA versus other uses

Loan uses	Freq.	Percent
Other uses	104	85.25
CSA	18	14.75

4.3 Credit market participation and intensity

This section presents and discusses econometric model results. A double hurdle model was estimated with first hurdle being household decision to participate in the credit market (decision to borrow) and the second hurdle for the intensity of participation (amount of loan demanded).The estimated results are presented below;

Table 9. Analytical results from double hurdle model

	Double Hurdle Model	
Variable	**Probit**	**Truncreg**
Age of the household head	0.002	-723.300
	(0.16)	(-0.65)
Gender of the household head	-0.606	59652.000
	(-1.16)	(1.23)
Education of the household head	0.204	-2337.800
	(0.76)	(-0.10)
Loan repayment period(months)	**0.233****	**8678.3*****
	(2.53)	(-6.31)
Collateral (group shares)	**1.697*****	**31677.600**
	(3.29)	(1.12)
Household saving	**0.700***	48551.700
	(1.8)	(1.29)
Wealth endowment	-0.091	**16275.300****
	(-1.25)	(2.59)
CSA investment	-0.053	-48059.200
	(-0.12)	(-1.30)
Primary occupation of HH head	0.385	**-65143.400***
	(0.98)	(-1.87)
Household size	0.055	7407.200

	(0.59)	(1.15)
No. of CSA practices adopted	0.214	-19815.800
	(0.72)	(-1.32)
NO. groups	**0.372***	**33607.900****
	(1.9)	(2.43)
Constant	-1.868*	-223502.000**
	(-1.88)	(-2.16)
Sigma		41541.9***
		(-5.47)
Log likelihood	-37.561	-855.147
LR chi2(12)	**80.650*****	-
Wald chi2(12)	-	**51.130*****
Pseudo R2	0.518	-
N	122	81
Test for comparison between Double hurdle and Tobit models		
Likelihood-ratio test		
LR chi2(12)	132.52	
Prob > chi2	0.0000	
Null Hypothesis: Tobit is nested in probit and truncated regression		

*t statistic in parentheses *<0.1 **<0.05 ***<0.01*

To choose the best and suitable model for the research study, we compared Tobit and double hurdle. The results show that Tobit is nested in double hurdle and thus we settled on double hurdle.

4.3.1 Credit market participation

Credit market participation was used to determine the number of farmers who took the decision and participated in the credit market. Figure 6 below shows that more male headed households participated in the credit market compared to women headed households. As discussed earlier, community groups are the main source of credit and women constitute the majority of the members in these groups, and this might explain why fewer female headed households didn't participate in the credit market. From descriptive statistics, table 5, more male headed household constituted majority of the households in the study and who participated in the credit market more. In those male headed households it's the women who are members of the community groups not the men. This explains why women form majority of the community groups' members and CBOs. The graph below shows household credit participation by gender of the household head.

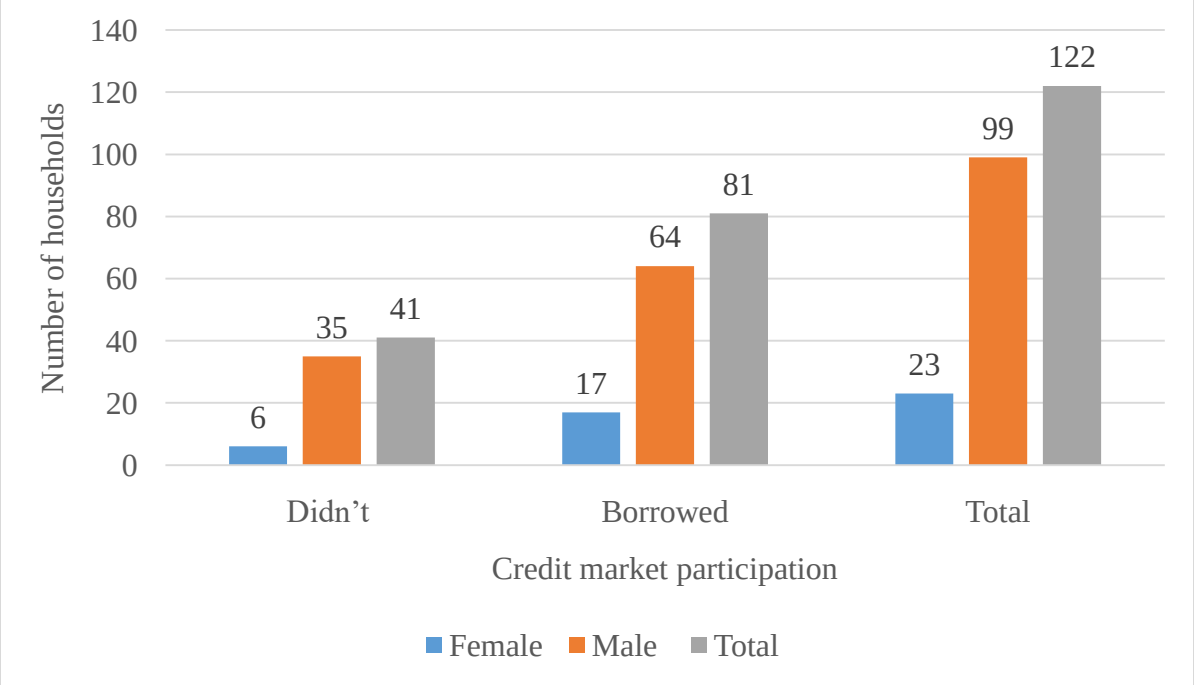

Figure 5: Graph credit market participation by gender

From the probit model results in Table 11, several factors influence credit market participation in Nyando basin. These factors are discussed below.

Loan repayment period: Loan repayment period showed a positive and significant correlation with household credit market participation at 5% significance level, mostly in the informal credit market. The longer the repayment period the more farmers are likely to participate in the informal credit market. If the loan repayment period is extended by 1 month, then household credit market participation is likely to increase by 4.9%. If the repayment period is spread over a longer period then farmers can pay back their loans without much strain. This also shows the flexibility is loan repayment which agrees with the findings of (Hussien 2007) in Ethiopia, where he found out that among other reasons farmers preferred credit from informal loan sources because of their flexibility in loan repayment in terms of amount and duration. Atieno, (2001) also agrees with the study finding that terms of loan repayment affect the decision of farmers to borrow.

Collateral (group shares): Farm household who used group shares as their loan collateral were likely to borrow more especially from the informal market (community and self-help groups). Using group shares as collateral showed a positive and significant relationship with decision to borrow at 1% significance level. If a household uses group shares as collateral their likelihood of borrowing will increase by 29%. It is easy to access a loan from the community groups if a farmer has shares as the farmers contributions will be used as collateral to guarantee the loan. If more lenders encourage and embrace use of group shares as collateral there is a high likelihood that credit market participation might be increased. Group membership and contribution help influence and improve credit access as they provide joint guarantee to loans applied by members (Akudugu et al.2009); (Armendariz and Morduch 2005) and (Kah et al. 2005).

Household savings: Household savings might influence credit demand both positively and negatively. From our findings, household saving had a positive and significant influence on farmers' decision to borrow at 10% significance level. If a household starts to save it's likely that their chances of borrowing will increase by16%. In our case farmers save through groups and the more shares a farmer has the more money they can access. Thus those with more savings can borrow larger amounts. According to Koomson et al. (2014) the probability of borrowing decreases with low savings and income and increase with high savings and high income.

Number of groups: Being in more groups has a positive and significant influence on informal credit market participation at 10% significance level. Membership in an extra group is likely to increases chances of participating in the informal credit market by 7.8 %.The more groups farm household members are in, the more likely they will borrow. The findings agree with Iyanda et al. (2014) who concluded that investment in social capital through actively being part of a group and participating in activities like decision making, increase the probability of credit access. Laffont and N'Guessan, (2000) agrees with the study finding that through groups farmers overcome the obstacle of information asymmetry especially in the remote areas for potential borrowers and thus the demand for credit will increase with an individual being a member of a group. Darie, (2012) in Uganda found out that groups provided social capital needed by smallholder farmers to access farm credit. Groups also provide training and mentorship on savings and credit and thus are critical in determining credit demand in rural areas of developing world (Huppi and Feder 1990).

4.3.2 Intensity of credit use

The truncated regression model in Table 11 shows that the following factors influence the intensity of participation in credit markets in Nyando Basin.

Loan repayment period: Loan repayment period showed a positive and significant correlation with amount of credit demanded. The longer the repayment period the more credit farmers are likely to demand. If the repayment period is increased with one month the amount demanded will increase by ksh. 8678.34. Holding other factors constant, with more time to repay, farmers might be encouraged to increase the amount they borrow. According to Atieno (2001) decision to borrow and amount of credit demanded is affected among other things by duration, amount and terms of payment given.

Wealth endowment: Household wealth endowment has a positive and significant influence on credit amount demand at 5% significance level. If the wealth index of a household increases with one unit, the amount demanded is likely to increase by ksh.16, 275.3. The more a household is endowed the more credit they are likely to borrow. This is because they have more assets that can be used as collateral for the loans or large parcels of land and thus need more resources to carry out operations on the farms. Also with large cultivated land size, the farm households utilize more farm inputs such as fertilizer, seed, labour (hired labour) and others that need additional resource that might be obtained through credit. Mohieldin and Write (2000) had similar findings in Egypt that borrowers who are characterized by greater assets and high earnings could use them as collateral and may demand for credit more. Jianqiang, & Bing (2008) and (Mpuga, 2010) cited that asset value and net worthy impacts demand positively. Farmers with high net worth and who own a lot of assets tend to exhibit high demand for loans because they can provide collateral for the loans and need more financial power to carry out their

operations. Miller and Ladman (1983) found out that households who borrow more are seen to have among other things high resource base and large number of cattle. Magri (2002) opined that at some level an increase in household wealth endowment might raise consumption levels which in turn increases demand for credit. Also Crook, (2001), Duca and Rosenthal, (1997), Gropp et al., (1997) and Cox and Jappelli, (1993) who find household wealth to be an important determinant of demand for credit.

Primary occupation: The influence of household head primary occupation on the amount of credit demanded especially from the informal market was found to be negative and significant at 10%. If household head is practicing agriculture as primary occupation then their amount of credit demanded will likely reduce by ksh.65, 143.38.According to Kiplimo et al., (2015) individuals engaged in agricultural sector as their main occupation (farmers) are unlikely to apply for credit as compared to their counterparts in other sectors. This may be as a result of risk of crop failure and unpredictability of agricultural production coupled with price fluctuation.

Additionally Laffont and N'Guessan, (2002) were of the opinion that households with regular off farm income and employment tend to participate and borrow more compared to those who are in agricultural sector as they can easily cushion themselves against risks of crop failure and livestock losses.

Number of groups: There was a positive and significance relationship between the number of groups and amount of credit demanded by farm households. The more community and self-help groups a household has subscribed to, the more likely that the amount borrowed will increase. If a household joins an extra one group the amount borrowed is likely to increase by Ksh.33, 607.91. Laffont and N'Guessan, (2000) observed that knowledge of each other among

smallholder farmers in groups overcome information asymmetry problem in credit financial markets, particularly in remote rural communities. Darie, (2012) in Uganda found out that groups provided social capital needed by smallholder farmers to access farm credit.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

According to Gabre-Madhin, et al., (2003) credit has been increasingly accepted as a vital instrument that help the poor rural households to escape the fangs of poverty as it helps enhance productivity through accumulating production assets. Despite its importance, access to credit still remains a challenge especially to the rural poor smallholder farmers. In the wake of climate change and its impacts, there is need for farmers to adopt, diffuse, out scale and upscale smart farming technologies in order to adapt and mitigate the impacts of climate change and variability. Understanding the credit needs of the smallholder farmers is key as it will help stakeholders design financial instruments to help them invest in these technologies, build and increase capacity.

From the descriptive statistics it's evident that most of the credit comes from informal sources and groups are the most important and preferred source of credit for the people of Nyando. Although Nyando farmers have realized and understood the importance and benefits of climate smart agriculture, a small percentage (15%) of these farmers are using loans to finance it. Among the farm households involved in the study at least 50% of them borrowing for School expenses.

Agricultural credit is crucial is bettering rural agricultural productivity. As shown from the model results flexible loan repayment terms, innovative use of collateral like groups shares, wealth endowment, farmers groups and household savings are key positive significant factors that influence demand for credit by smallholder rural farmers while primary occupation (agriculture) has a negative effect on credit demand.

Use of group shares as collateral is commonly used to secure credit as most borrowing is from community self-help groups. Access to formal credit seems limited and the choice of it not

preferred by many. The results confirms that smallholder's farmers might be credit constrained or rationed as practicing agriculture as the main occupation shows a negative correlation with credit demand.

Based on the above conclusions the study recommends that:

- The government in collaboration with NGOs and other stakeholders should fast track the implementation of the climate smart agriculture strategic plan (2017-2026) alongside providing CSA tailored financing options to help adoption, up scaling and out scaling of CSA.
- The state and other stakeholders should consider using groups as a financing avenue as they have shown high success rate thus a viable option for credit provision to the needy poor farmers compared to set ups that crop up every time there is a government or NGO credit package.
- Financing and lending stakeholders (formal) need to consider simplifying lending procedures and making loan repayments and collateral flexible enough to the reach of the needy poor farmers and using the groups financing model to penetrate this section of the population.
- Groups provide social capital which act as collateral when accessing credit, and can be used for technological transfer awareness. Thus if a government intends to penetrate rural finance to the rural farmers they can do so by using groups as opposed to ad hoc-set ups that normally mushroom when a finance package arise.
- Farmers especially rural smallholder farmers practicing agriculture are more credit constrained and prone to risks and losses as opposed to the other economic sectors, and

the state can help them by providing crop and livestock insurance facility through farmer groups to cushion them against farming risks.

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